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Effect of preadmission bowel preparation on outcomes of elective colorectal procedures in young children☆

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ABSTRACT

Background: The utility of mechanical bowel preparation (MBP) to minimize infectious complications in elective colorectal surgery is contentious. Though data is scarce in children, adult studies suggest a benefit to MBP when administered with oral antibiotics (OAB).
Methods: After IRB approval, the Pediatric Health Information System (PHIS) was queried for young children undergoing elective colon surgery from 2011 to 2014. Patients were divided into: no bowel preparation (Group 1), MBP (Group 2), and MBP plus OAB (Group 3). Statistical significance was determined using univariate and multivariate analysis with GEE models accounting for clustering by hospital.
Results: One thousand five hundred eighty-one patients met study criteria: 63.7% in Group 1, 27.1% in Group 2, and 9.2% in Group 3. Surgical complication rate was higher in Group 1 (23.3%) compared to Groups 2 and 3 (14.2% and 15.5%; $P < 0.001$). However, median length of stay was shorter in Group 1 (4, IQR 4 days) compared to Group 2 (5, IQR 3) and Group 3 (6, IQR 3) ($P < 0.001$). 30-day readmission rates were similar. In multivariate analysis compared to patients in Group 1, the odds of surgical complications were 0.72 (95% CI 0.40–1.29, $P = 0.28$) with MBP alone (Group 2), 1.79 (95% CI 1.28–2.52, $P = 0.0008$) with MBP + OAB (Group 3), and 1.13 (95% CI 0.81–1.58, $P = 0.46$) for the aggregate Group 2 plus 3.
Conclusion: Utilization of bowel preparation in children is variable across children's hospitals nationally, and the benefit is unclear. Given the discrepancy with adult literature, a three-armed pediatric-specific randomized controlled trial is warranted.
Level of evidence: Level III treatment study – retrospective comparative study.

Surgical site infections (SSI) occur in 13–25% of children after elective colorectal surgery, with significant resulting morbidity for patients and costs to the healthcare system [1–3]. Mechanical bowel preparation (MBP) prior to surgery has been utilized routinely since the 1970's to theoretically minimize infectious and anastomotic complications. The specific regimen used for preparation has evolved over the years, along with its perceived efficacy. MBP with oral antibiotics (OAB) was originally used and widely popularized by Nichols and Condon [4,5]. MBP alone has also been used extensively and has over time become the preferred method by most surgeons. The efficacy of bowel preparation in reducing post-operative complications, length of stay (LOS), and readmission rates has been disputed in multiple trials, which has resulted in a significant reduction in the utilization of MBP [6–9]. However, more recent high quality, randomized trials in adults have shown a benefit to MBP + OAB compared to MBP alone, and suggested that bowel preparation may in fact be beneficial when administered as MBP + OAB [10–15].

There has been a paucity of studies in the pediatric population on the utility of bowel preparation, so current recommendations in pediatric surgery are based largely on adult literature. Breckler et al. in 2010 found no difference in SSI incidence in pediatric patients who underwent MBP with or without OAB [16]. Current trends in pediatric hospitals continue to favor the use of no preparation over MBP alone or MBP + OAB [17,18].

The purposes of this study are (1) to assess the current use of bowel preparation regimes for elective colorectal surgeries in young children using a national administrative database and (2) determine the association between bowel preparation regimens and post-operative

Abbreviations: MBP, mechanical bowel preparation; OAB, oral antibiotics; PHIS, Pediatric Health Information System; SSI, surgical site infections; CI, confidence interval; IQR, interquartile range.

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complications. This large, retrospective database study aims to clarify whether adult guidelines are clearly applicable to pediatric patients or whether additional, prospective data is needed to establish pediatric guidelines.

1. Methods

1.1. Data search

Data for this study were obtained from the Pediatric Health Information System (PHIS), an administrative database that contains inpatient, emergency department, ambulatory surgery and observation encounter-level data from over 45 not-for-profit, tertiary care pediatric hospitals in the United States. These hospitals are affiliated with the Children's Hospital Association (Overland Park, KS). Data quality and reliability are assured through a joint effort between the Children's Hospital Association and participating hospitals. Portions of the data submission and data quality processes for the PHIS database are managed by Truven Health Analytics (Ann Arbor, MI). For the purposes of external benchmarking, participating hospitals provide discharge/encounter data including demographics, diagnoses, and procedures. Nearly all of these hospitals also submit resource utilization data (e.g. pharmaceuticals, imaging, and laboratory) into PHIS. Data are de-identified at the time of data submission, and data are subjected to a number of reliability and validity checks before being included in the database. For this study, data from 45 hospitals was included. Although de-identified, records contain an encrypted medical record number that allows tracking of individual patients across multiple inpatient and outpatient encounters.

The PHIS database was queried from 1/1/2011 to 12/31/2014 for patients younger than 10 years of age undergoing elective procedures involving a colonic anastomosis. Analysis was limited to children <10 years of age because it is only possible to capture bowel preparations administered in the inpatient setting. Older children who were more likely to have had a bowel preparation as outpatients were excluded. Analysis was also limited to children who underwent their primary procedure on hospital day 0, 1, or 2. Patients were considered to have a bowel preparation if their procedure was on day 1 or 2 and they had pharmacy charges for MBP (polyethylene glycol or magnesium citrate) and/or OAB (neomycin or erythromycin) beginning on day 0 or 1. Patients were not assumed to have a bowel preparation just because they were pre-admitted prior to surgery. Patients with Hirschsprung's disease (ICD-9751.3), atresia of the large intestine (ICD-9751.2) and inflammatory bowel disease (ICD-9555.0–555.2 or 556.1–556.9) were identified by diagnosis codes across all encounters.

Patients undergoing colonic anastomosis were identified based on ICD-9 procedure codes 17.33, 17.35, 45.71, 45.72, 45.76, 45.79, 45.81, 45.82, 45.83, 45.94, 46.52. Patients undergoing anorectal anastomoses were excluded given the study design's inability to discern if they had a pre-existing proximal diverting ostomy at the time of surgery. We identified 2632 patients meeting initial inclusion and exclusion criteria. Among these 2632 patients, 32 received a bowel preparation consisting of oral antibiotics alone. This number was considered too small for analysis, so these patients were excluded from further analysis.

1.2. Experimental groups

Included patients were divided into three groups for analysis: Group 1: No bowel preparation; Group 2: MBP alone; Group 3: MBP + OAB. The primary outcome measure was aggregate surgical complications. This flag is identified in PHIS based on the presence of one or more ICD-9 diagnosis codes referenced in PHIS Flag Code Lists - FY 2013 [19]. Complications were further characterized based on PHIS flags (infectious complication), and/or specific ICD-9 codes (wound infection, anastomotic leak, wound dehiscence). Secondary outcome measures were hospital length of stay (LOS) and readmission within 30 days (to the emergency department, observation unit, or inpatient care unit).

1.3. Statistical analysis

Categorical variables were compared by chi-square analysis. Length of stay was not normally distributed. Medians were therefore compared between groups using the Independent Samples Kruskal-Wallis test. Multivariate analysis was performed using general estimating equations (GEE). Odds ratios were obtained from GEE models accounting for the clustering within hospitals and adjusted for gender, race, ethnicity, payer, and procedure level. $P < 0.05$ was considered significant.

2. Results

2.1. Demographics

1581 patients met study criteria and were included in the analysis. 952 (60.2%) were male. 964 (61.0%) patients were white, 220 (13.9%) black, 79 (5.0%) Asian, and 318 (20.1%) other or unknown. 295 (18.7%) were of Hispanic ethnicity. The primary payer was commercial insurance in 637 (40.3%) and government insurance in 875 (55.3%). The majority of patients were less than 1 year of age (839, 53.1%). Mean age was 1.7 ± 2.6 years. Among this cohort, 170 (10.8%) had a diagnosis of Hirschsprung's disease, 392 (24.8%) had atresia of the large intestine (including anorectal malformation), and 47 (3.0%) had inflammatory bowel disease.

Among these 1581 patients who underwent colonic anastomosis, 1007 (63.7%) received no preoperative bowel preparation, 429 (27.1%) had MBP alone and 145 (9.2%) received MBP + OAB. The demographic characteristics of patients in each treatment group are compared in Table 1. Patients who were older than 1 year of age, White race, or non-Hispanic ethnicity were more likely to get MBP ± OAB. Hospital variations in bowel preparation strategy are shown in Fig. 1, with some hospitals using no preparation as the only strategy and others using MBP alone or with OAB for all their patients.

2.2. Outcomes

In univariate analysis, the incidence of surgical complications was higher for the no preparation group 235 (23.3%) compared to 61

Table 1
Demographic and baseline characteristics of patients undergoing elective colon surgery stratified by preoperative bowel preparation strategy.

	Group 1 No prep	Group 2 MBP	Group 3 MBP + OAB	*P*
Age (mean + SD)	2.1 +/− 2.3	2.8 +/− 1.7	2.6 +/− 2.3	<**0.001**
Age Group				<**0.001**
0	585 (69.7%)	192 (22.9%)	62 (7.4%)	
1–4	277 (58.0%)	141 (29.5%)	60 (12.6%)	
5–9	145 (54.9%)	96 (36.4%)	23 (8.7%)	
Gender				0.11
Male	605 (63.6%)	270 (28.4%)	77 (8.1%)	
Female	402 (63.9%)	159 (25.3%)	68 (10.8%)	
Race				**0.035**
White	615 (63.8%)	243 (25.2%)	106 (11.0%)	
Black	140 (63.6%)	68 (30.9%)	12 (5.5%)	
Asian	51 (64.6%)	21 (26.6%)	7 (8.9%)	
Other/Unknown	201 (63.2%)	97 (30.5%)	20 (6.3%)	
Ethnicity				**0.003**
Hispanic	198 (67.1%)	87 (29.5)	10 (3.4%)	
Not Hispanic	713 (63.4%)	296 (26.3%)	115 (10.5%)	
Other/Unknown	96 (59.3%)	46 (28.4%)	20 (12.3%)	
Primary Payer				0.20
Commercial	410 (64.4%)	159 (25.0%)	68 (10.7%)	
Government	558 (63.8%)	247 (28.2%)	70 (8.0%)	
Other/Unknown	39 (56.5%)	23 (33.3%)	7 (10.1%)	
Admission Year				0.10
2011	229 (59.9%)	117 (30.6%)	36 (9.4%)	
2012	243 (61.7%)	117 (29.7%)	34 (8.6%)	
2013	255 (63.4%)	107 (26.6%)	40 (10.0%)	
2014	280 (69.5%)	88 (21.8%)	35 (8.7%)	